

Observed and simulated extreme daily precipitation

NOAA
Boulder, CO
September 10, 2014

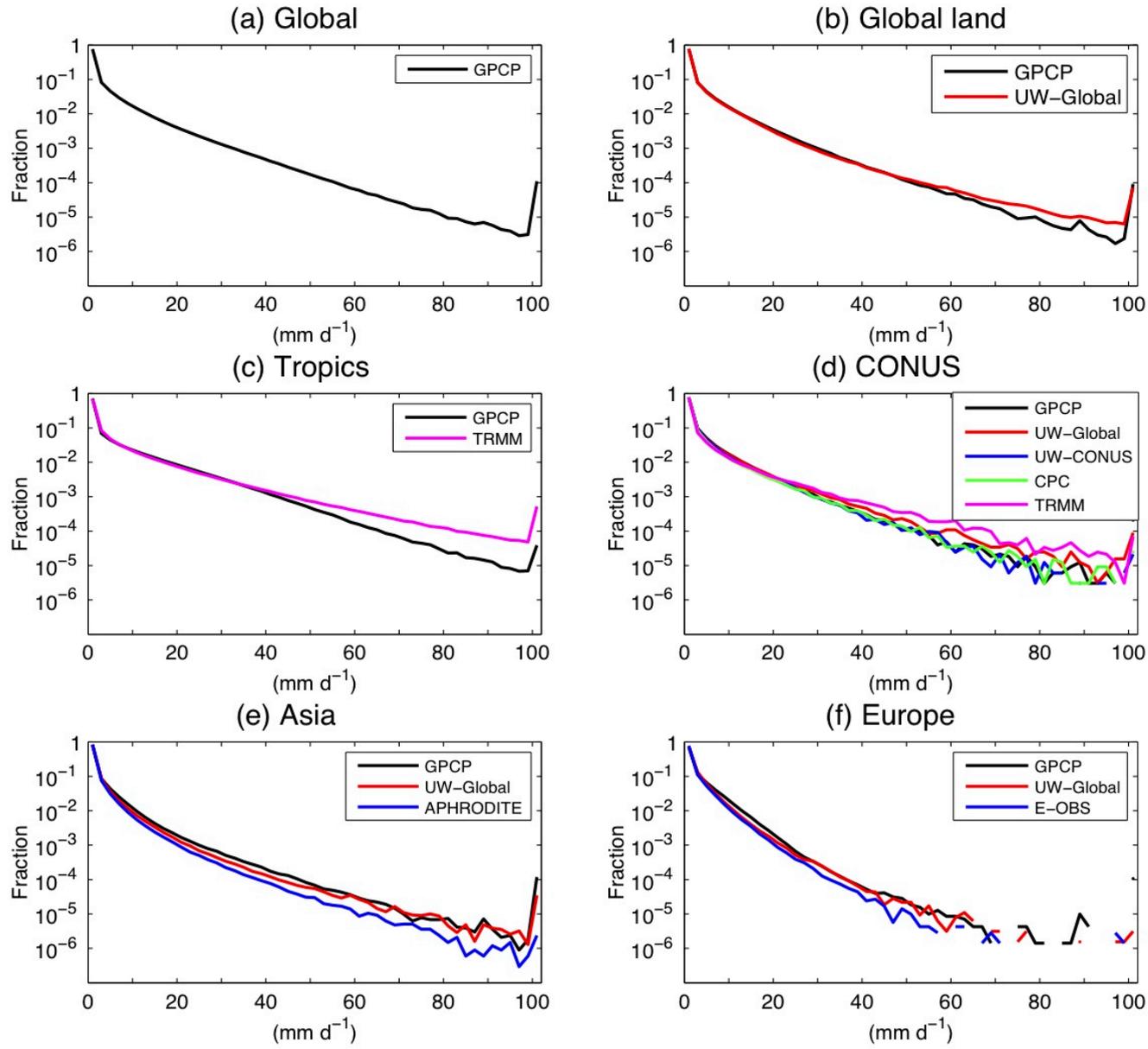
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Lawrence Berkeley National Laboratory
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Extreme daily precipitation

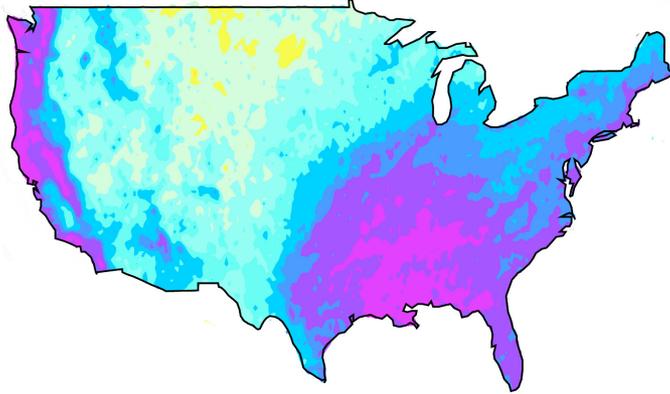
- How well do we know extreme precipitation in the real world?
- Gridded Observations
 - At least 8 different daily data sets:
 - GPCP: Global ocean and land 1°
 - UW Global: Land only. 0.5°
 - TRMM: 50S-50N 0.25°
 - CPC: CONUS: 0.25°
 - UW CONUS: 0.125°
 - E-obs: Europe 0.25°
 - APHRODITE: Asia 0.25°
 - PERSIANN: 60S-60N 0.25°
- They differ in the tails of the distribution.

Normalized PDF of observed daily precipitation (mm/day)

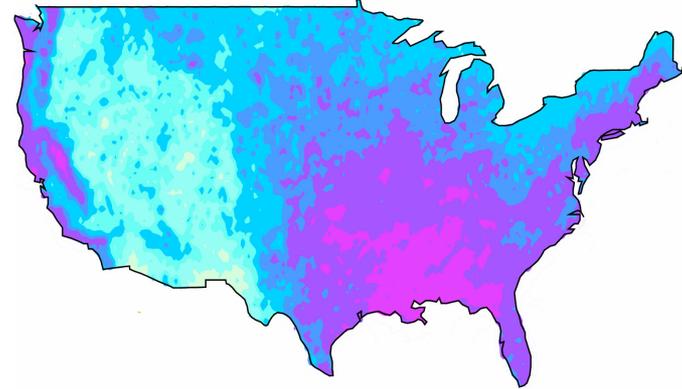


20 year return value of seasonal maximum daily precipitation

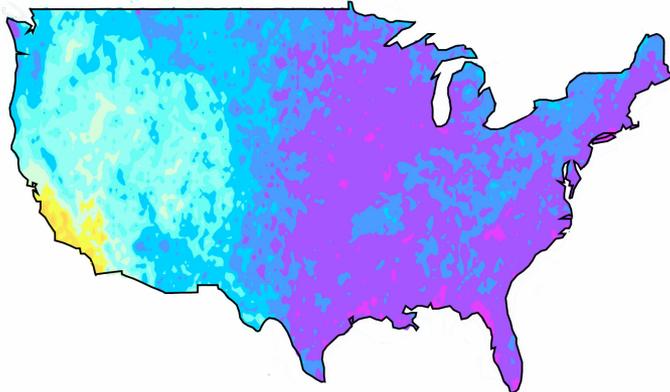
Observation: NOAA CPC
DJF



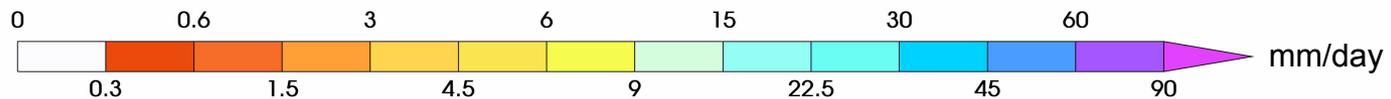
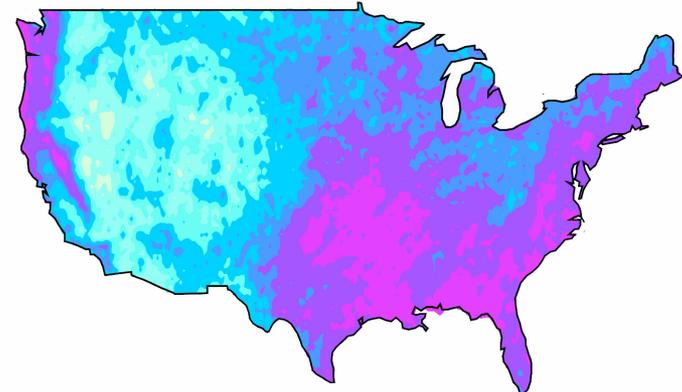
MAM



JJA

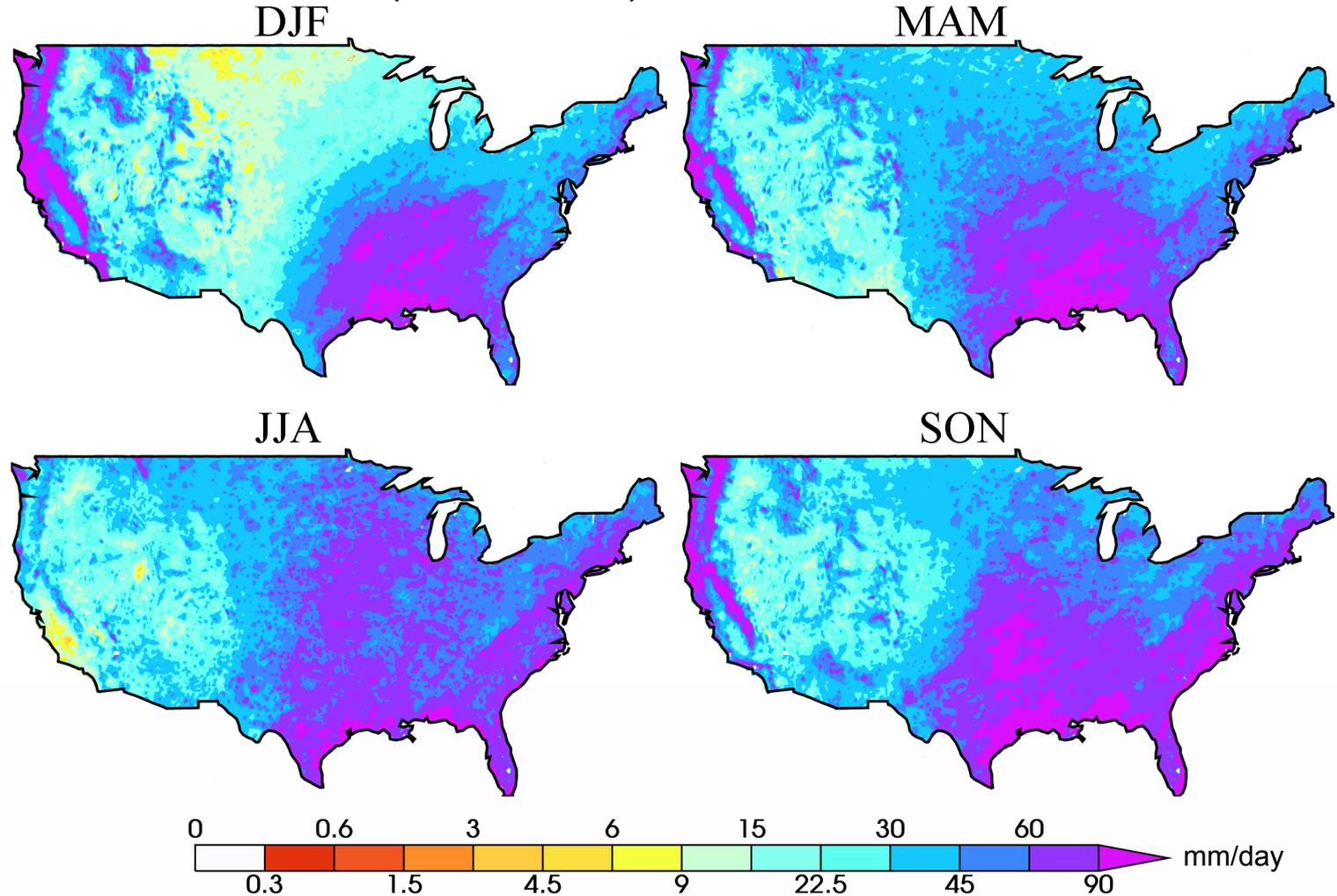


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20 year return value of seasonal maximum daily precipitation

Observation: UW CONUS (Maurer et al)

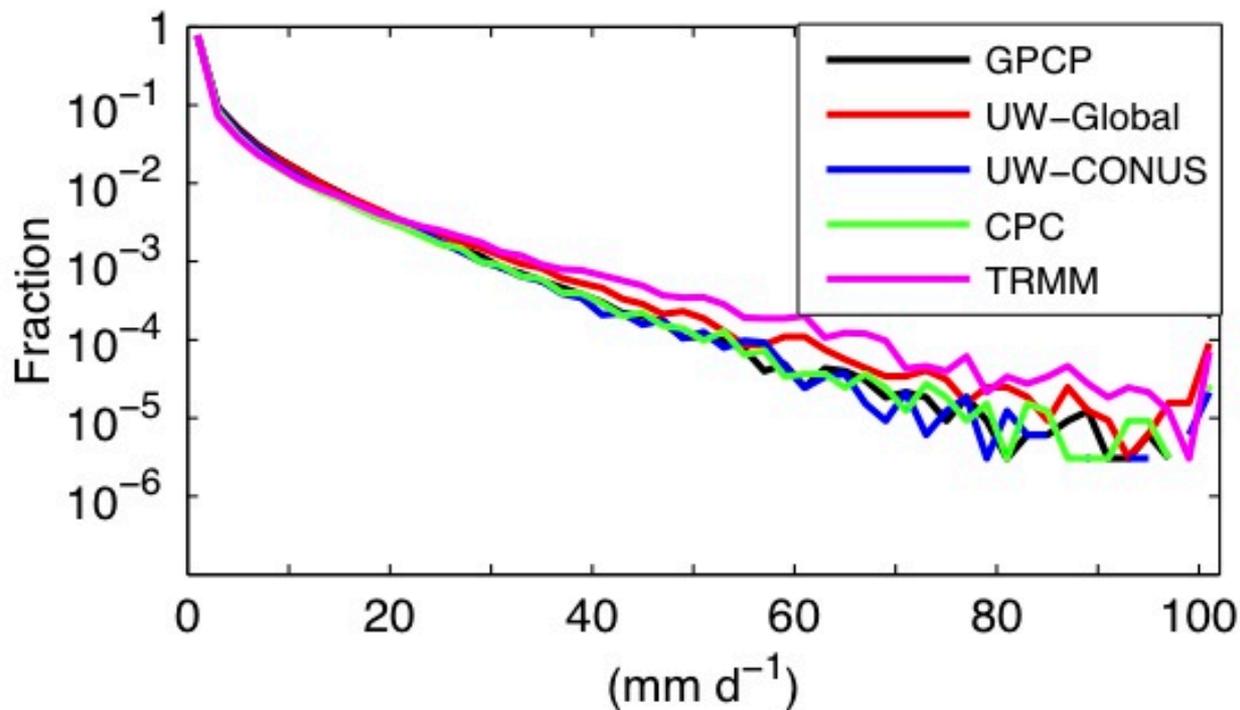


CPC vs UW CONUS

- Differences in mean precipitation are small.
- Differences in the tail of the distribution are small when averaged over CONUS.
 - Well, maybe not...
- Local details in the 20 year RV are large in the mountainous Western US.
 - Almost certainly due to the elevation correction (PRISM) in the UW dataset.
 - Can we get NOAA to apply this correction to the CPC dataset?
- Eastern US difference is unexplained.
 - Shorter record?

Seasonality:

Summer is lower than
the other seasons in
the east.





Simulated extreme precipitation

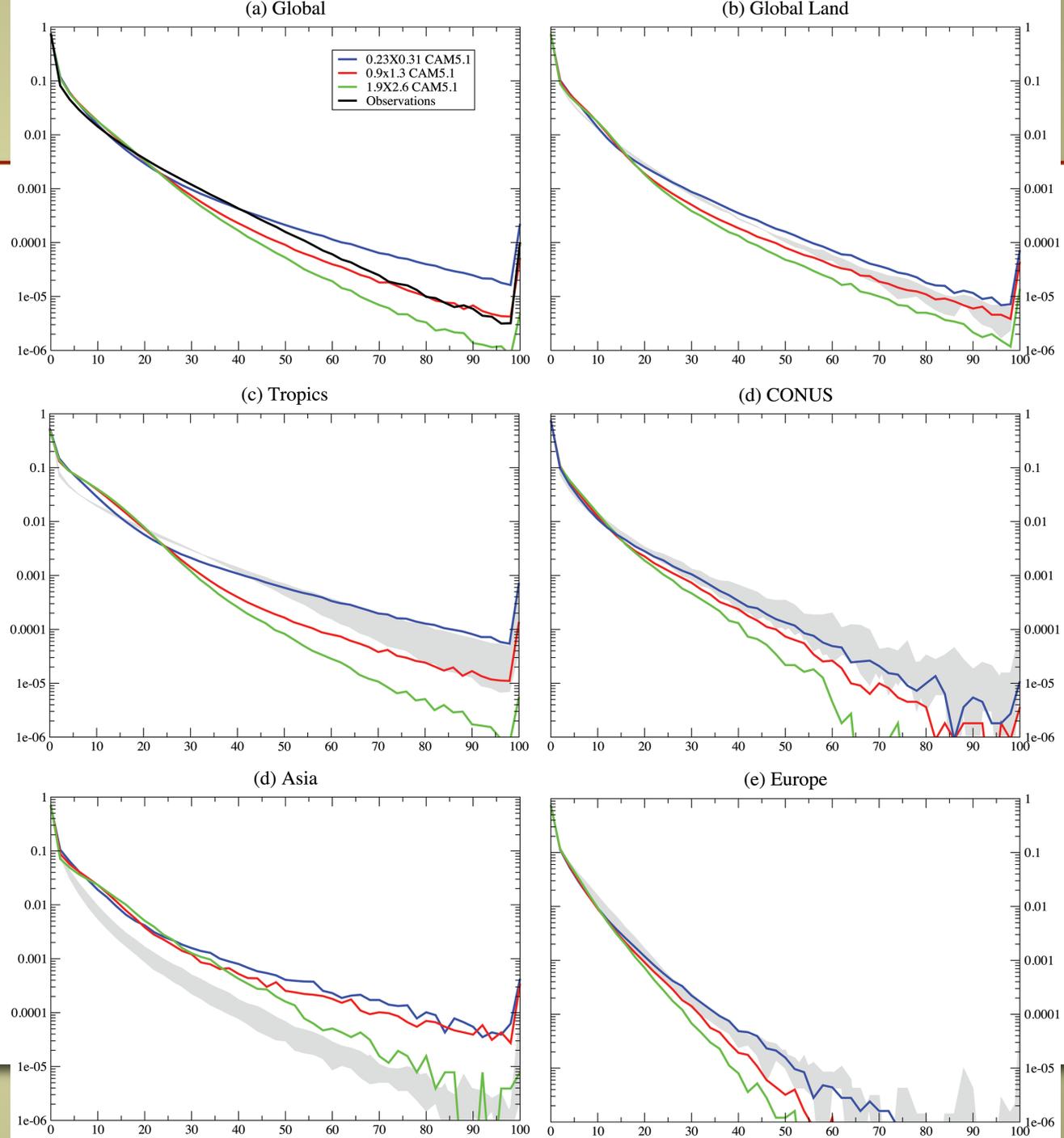
- Resolution study using a global AGCM
 - Community Atmospheric model, fvCAM5.1
 - 200, 100, 25km (at the equator)
 - 1979-2005 AMIP
- NARCCAP multimodel RCM comparison
 - 8 different models
 - ~50km resolution



Precipitation

Daily Precipitation
fvCAM5 vs. obs.

Observational range is
shown as gray.
A crude measure of
Observational uncertainty.

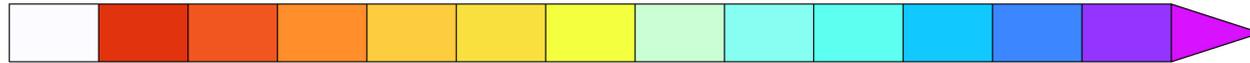
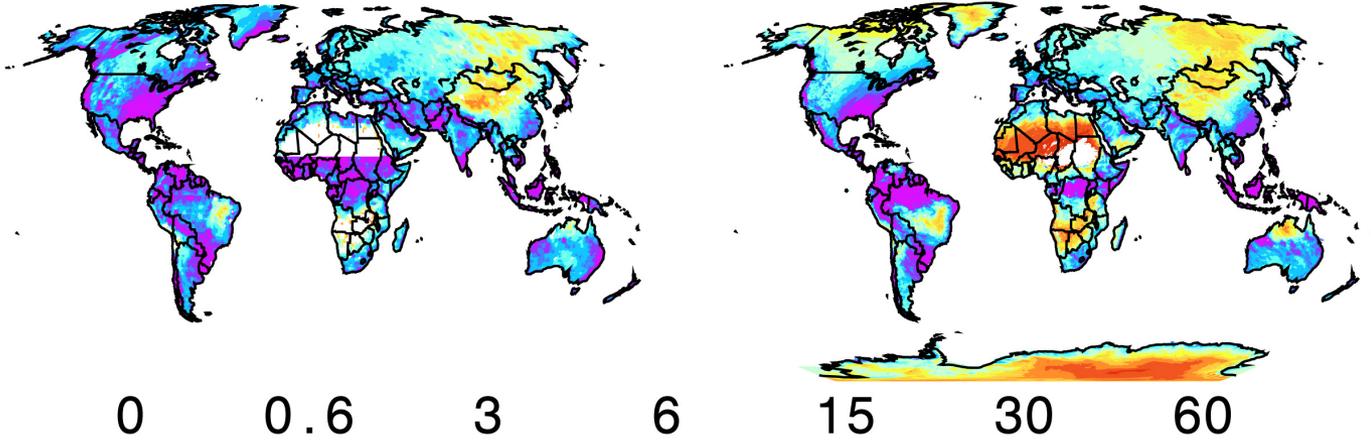


Extreme precipitation: Winter 20 year RV

Winter

UW-Global

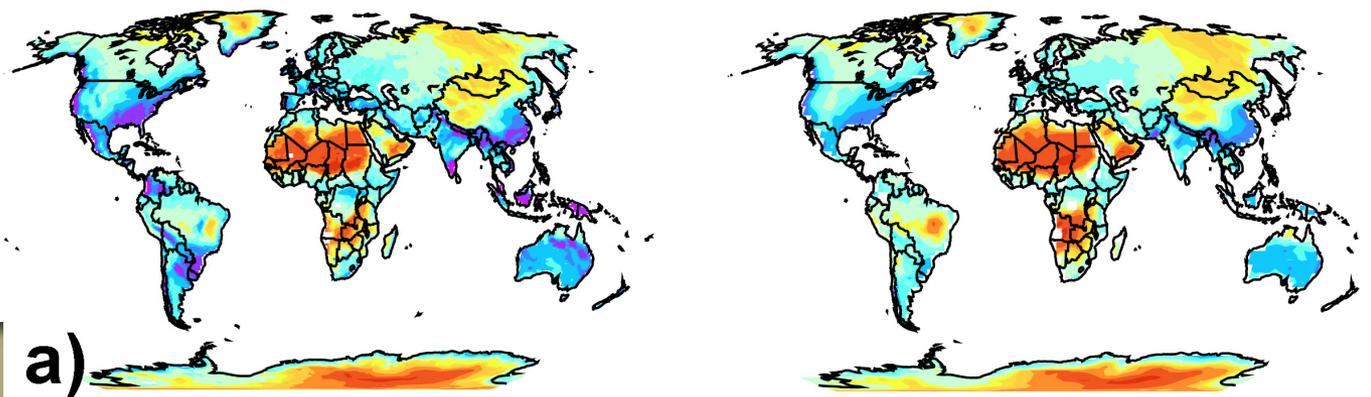
0.25° fvCAM5.1



0.3 1.5 4.5 9 22.5 45 90

1.0° fvCAM5.1

2.0° fvCAM5.1

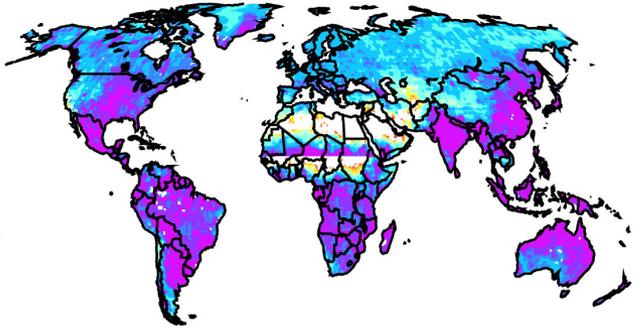


mm/day

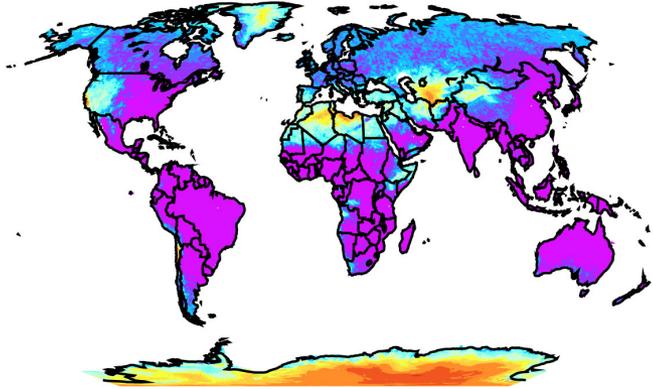
Extreme precipitation: Summer 20 year RV

Summer

UW-Global



0.25° fvCAM5.1

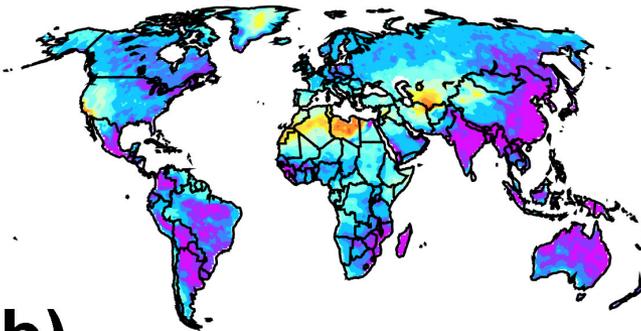


0 0.6 3 6 15 30 60

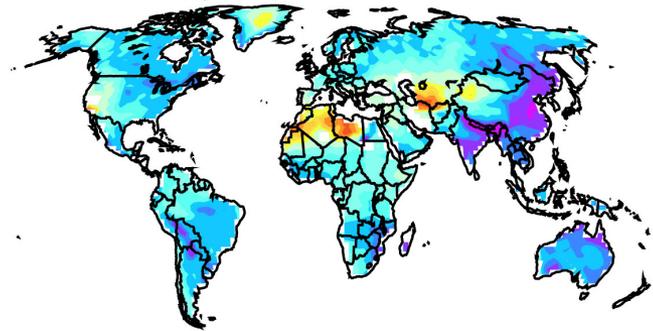


0.3 1.5 4.5 9 22.5 45 90

1.0° fvCAM5.1



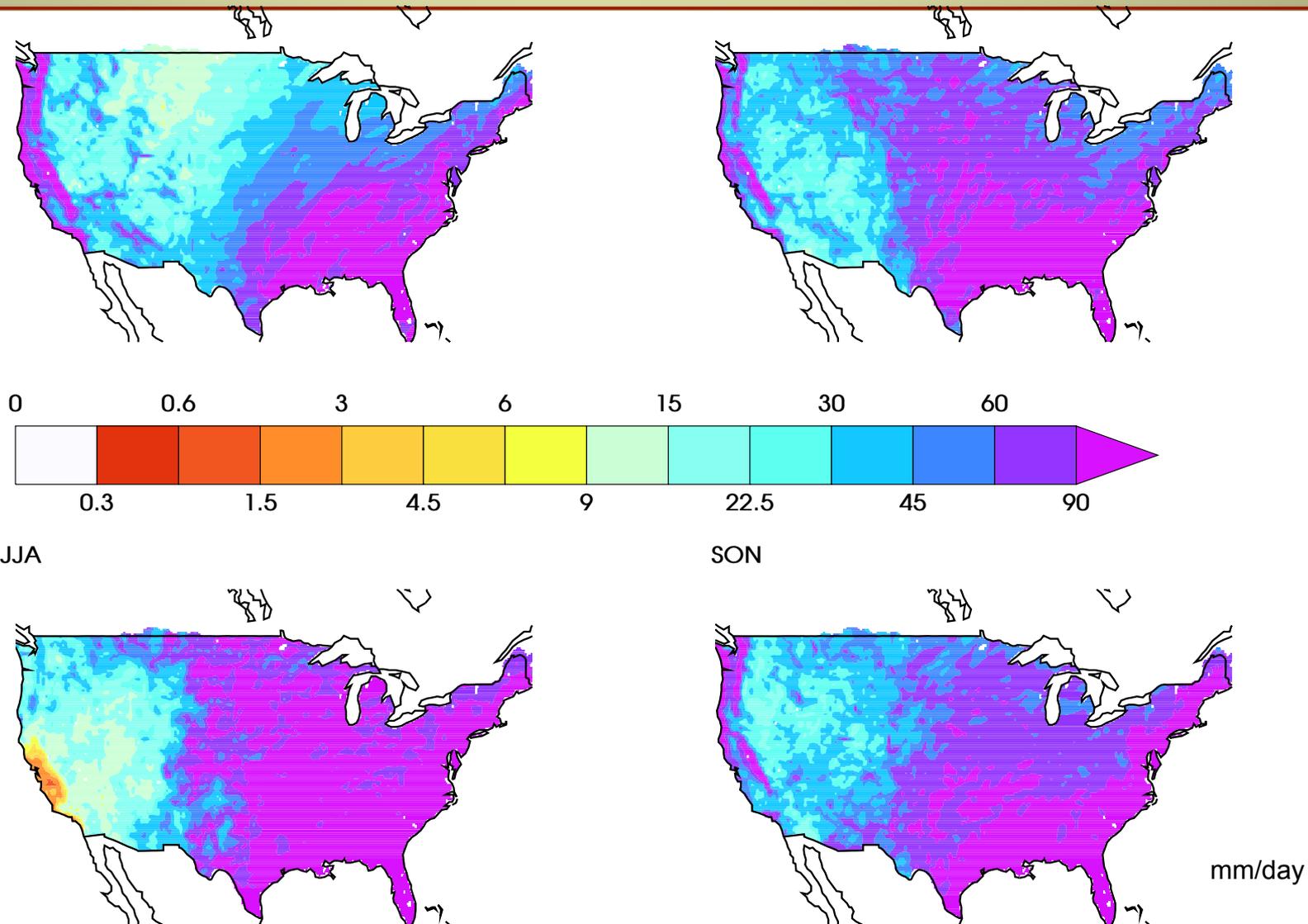
2.0° fvCAM5.1



mm/day

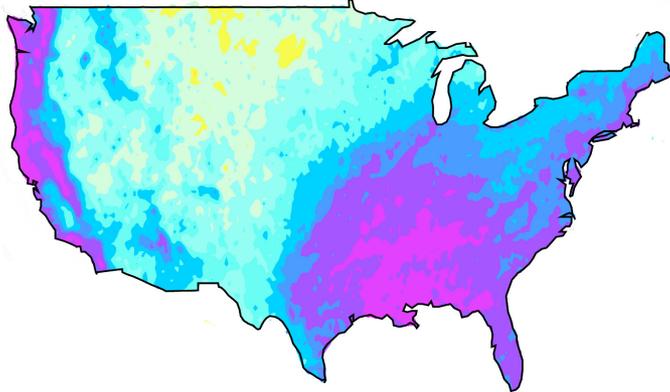
b)

20 year seasonal RV: 0.25° fvCAM5.1

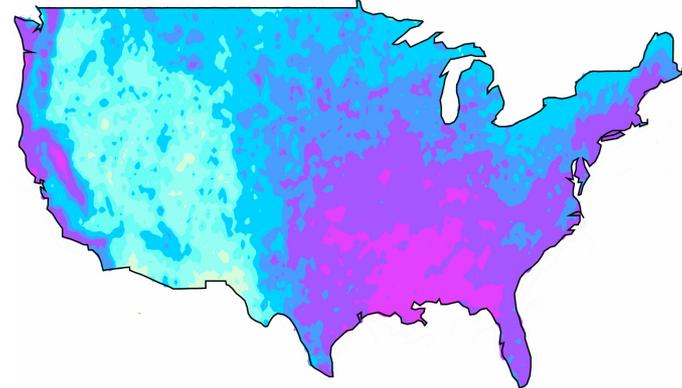


20 year return value of seasonal maximum daily precipitation

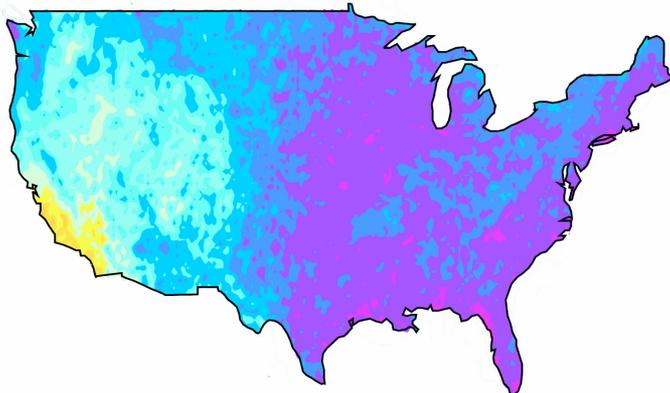
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DJF



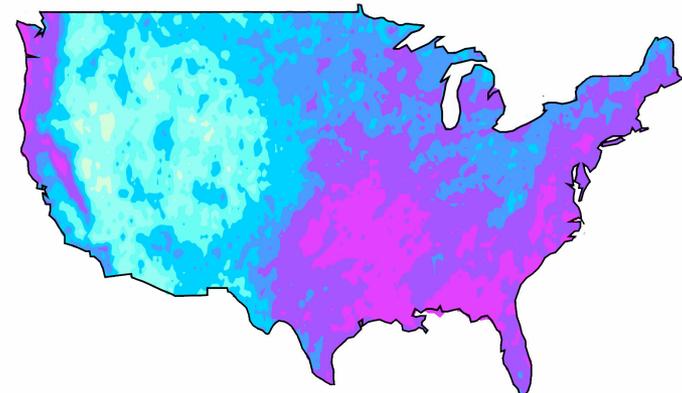
MAM



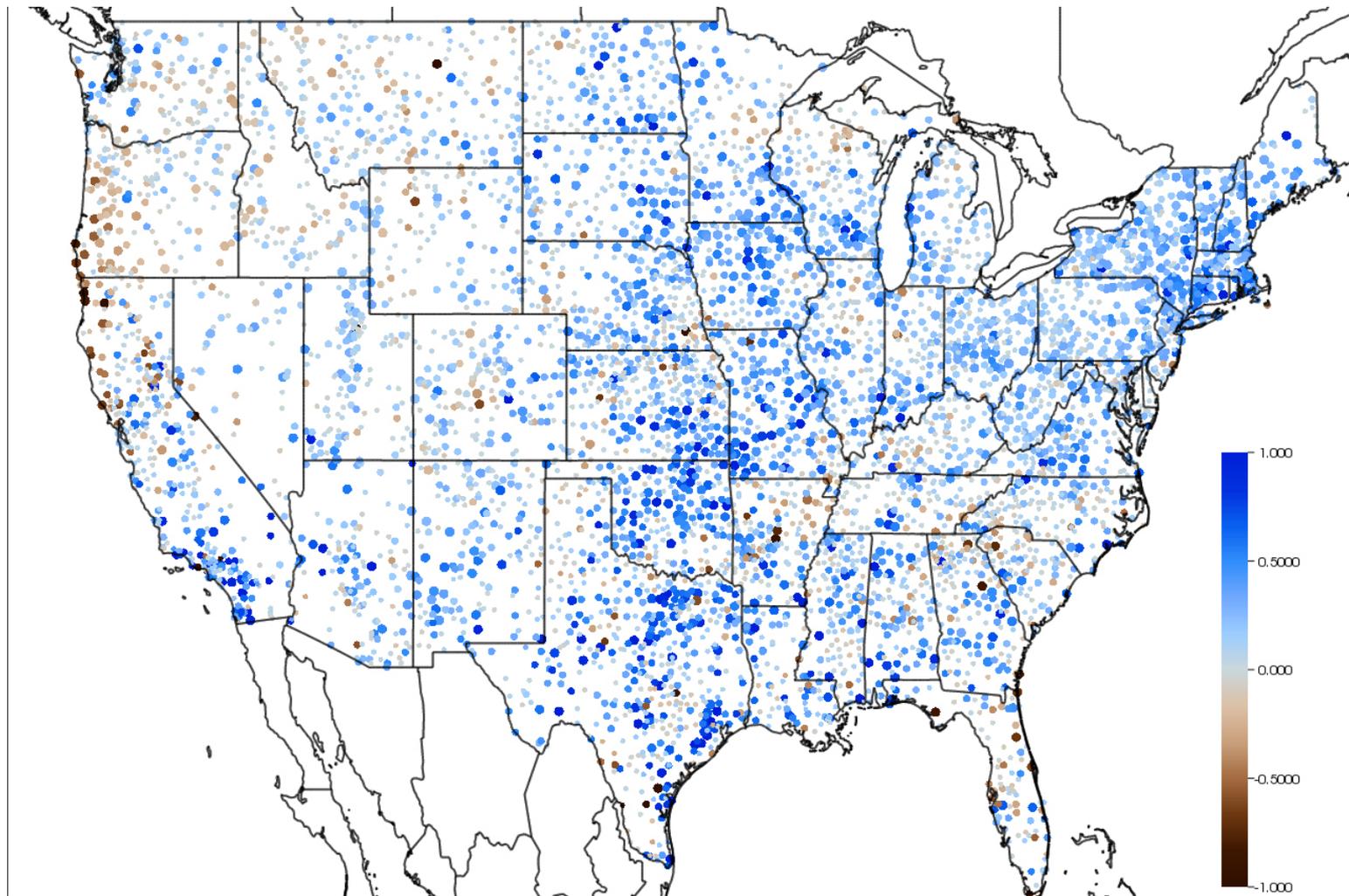
JJA



SON



Change in 20 year Return value

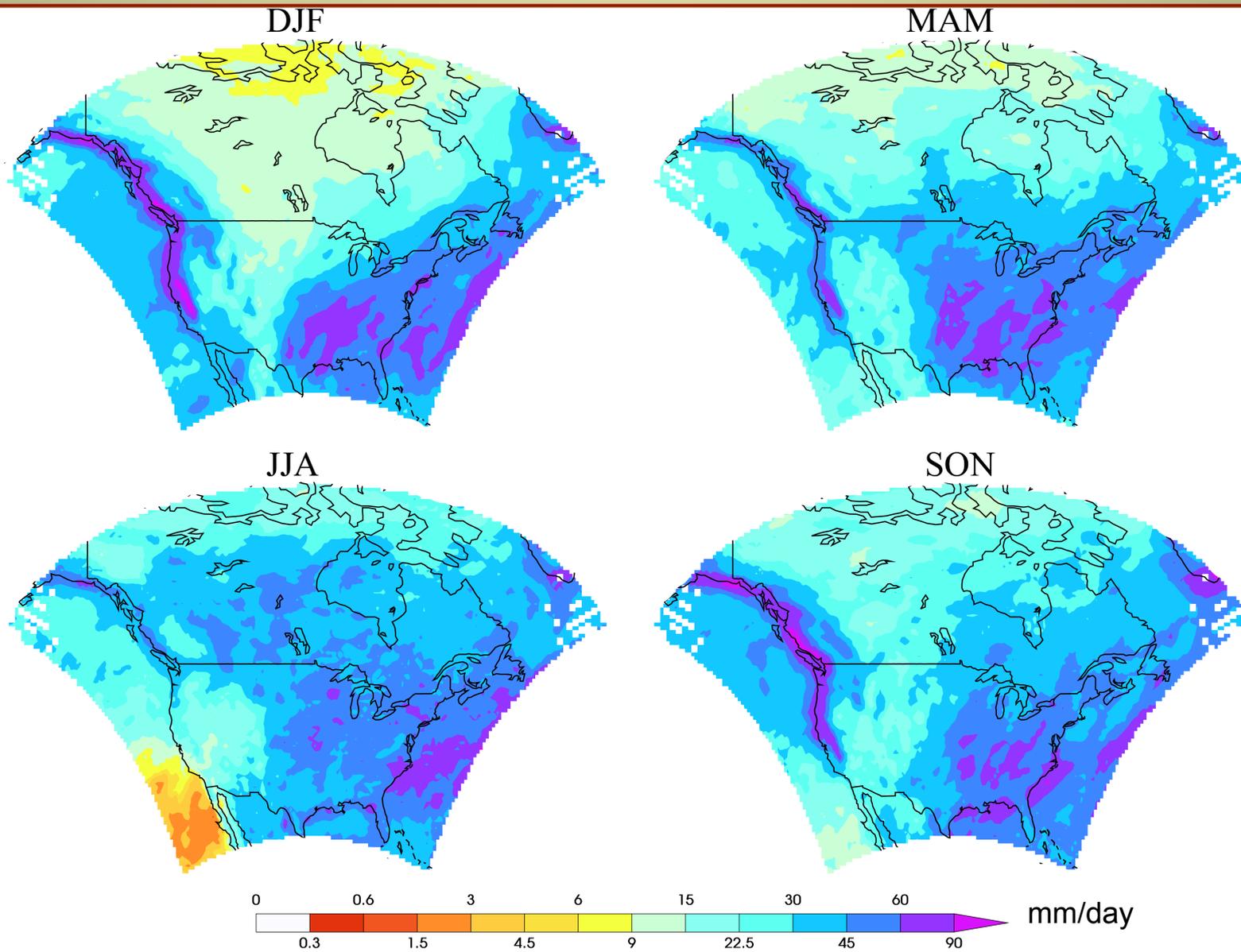


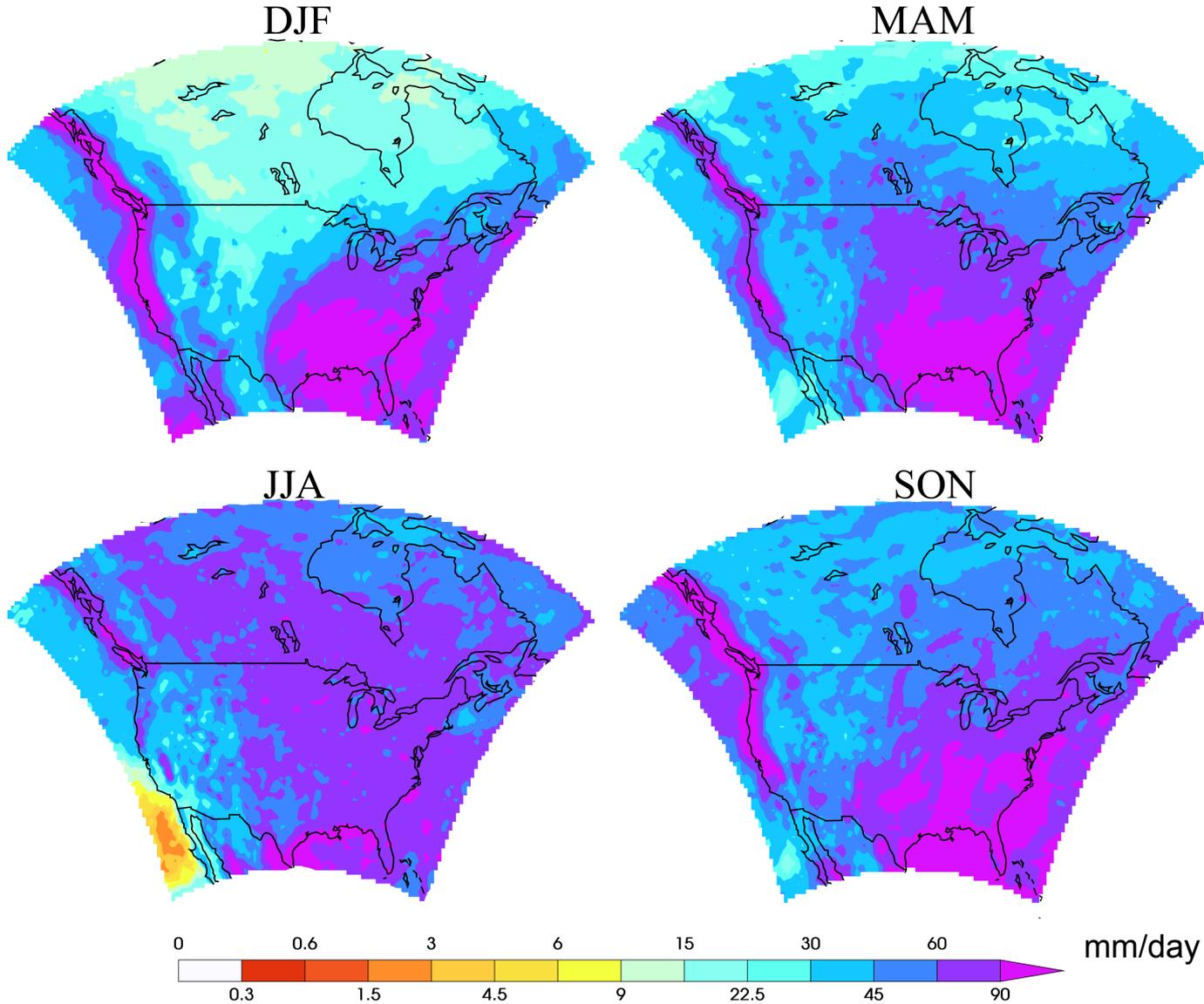


Simulated extreme precipitation

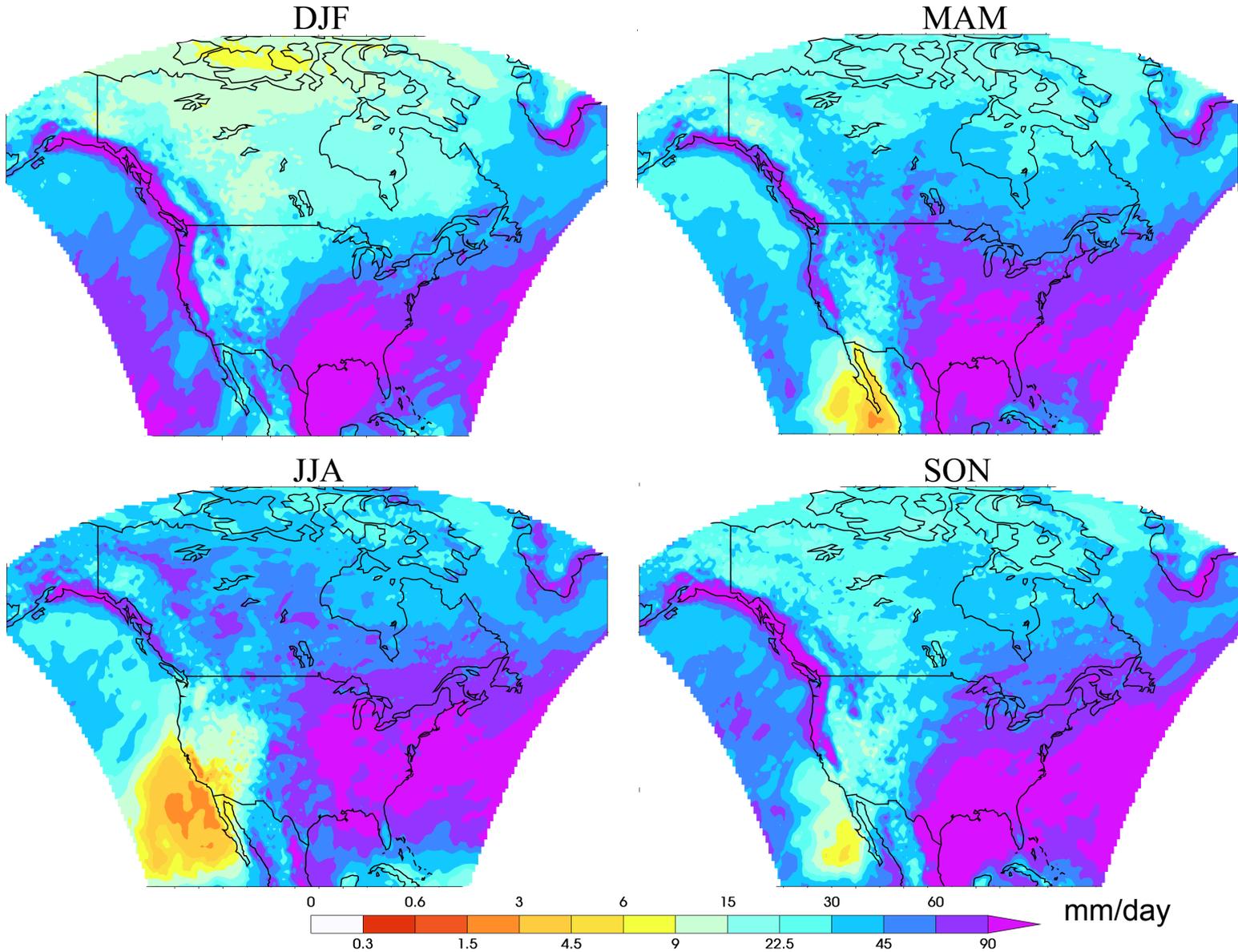
- Low resolution models do not produce enough extreme precipitation.
 - Simulated storms are not intense enough.
 - Moisture gradients are not sharp enough
- High resolution fvCAM5.1
 - Fails to reproduce the seasonal cycle in extreme precipitation.
 - Summer is much larger than the other seasons in the Eastern US
 - Other seasons are better.
 - A little too high in the CONUS and Europe
 - Much too high in Asia (but observations are more uncertain)
- **Failure in the summer is almost certainly traceable to the cumulus convection parameterization.**
 - Mismatch of the convective time scale and the physics time step
 - Similar errors in the NARCCAP ensemble

CRCM (ncep)

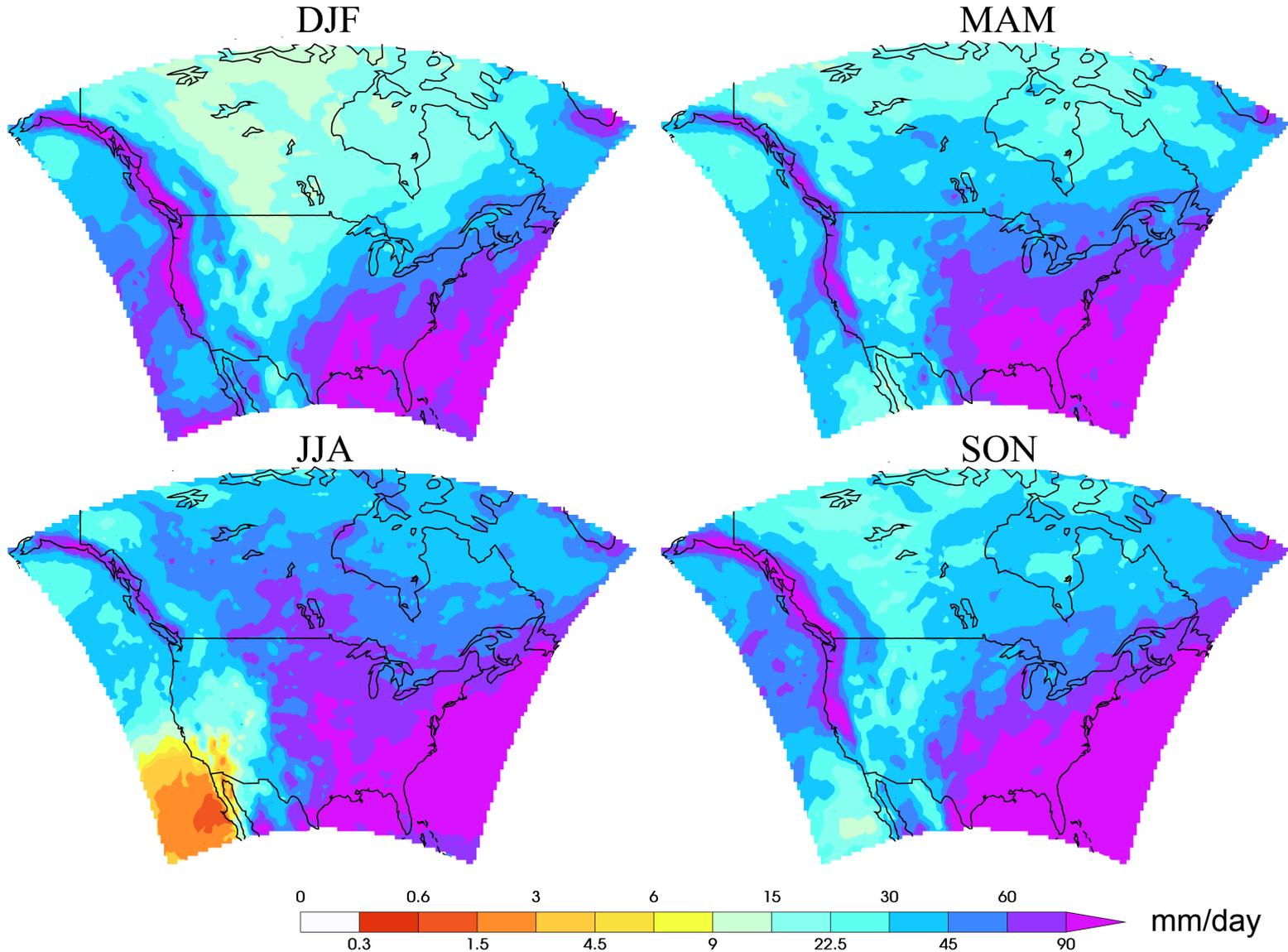




HRM3 (ncep)



MM5I (ncep)



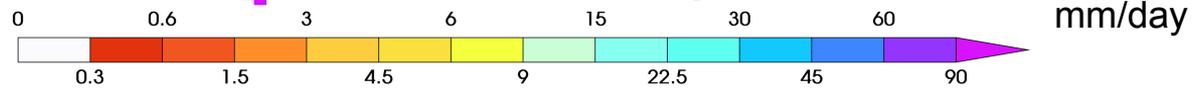
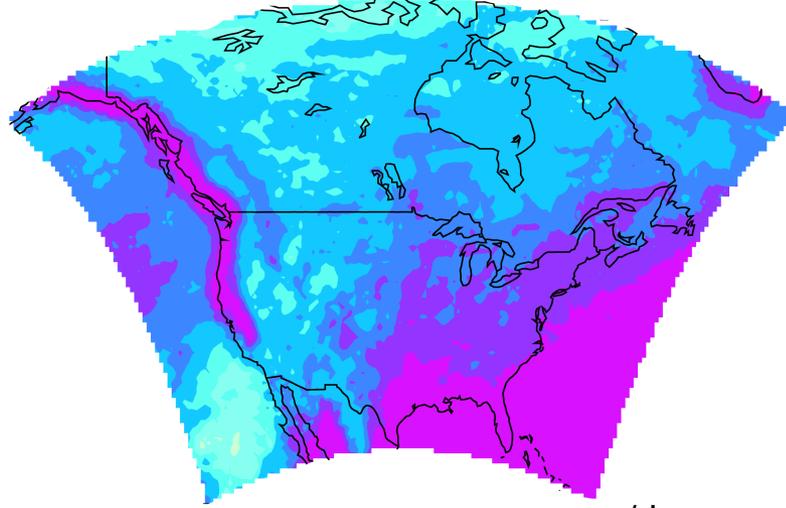
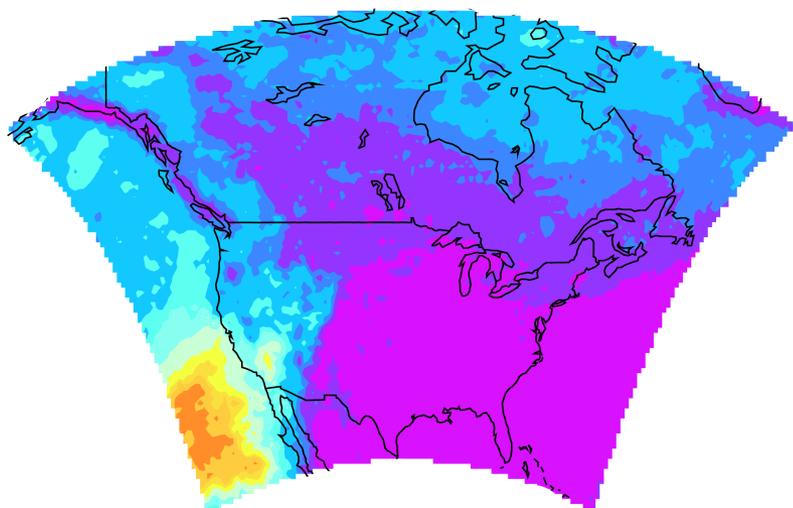
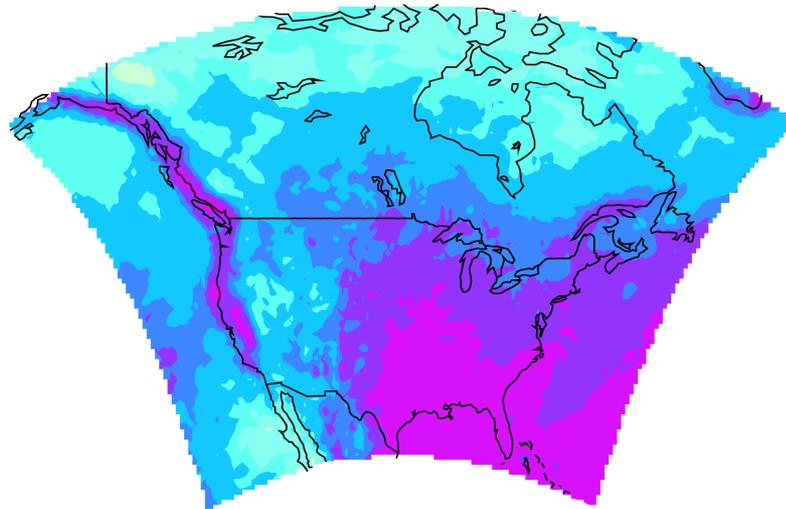
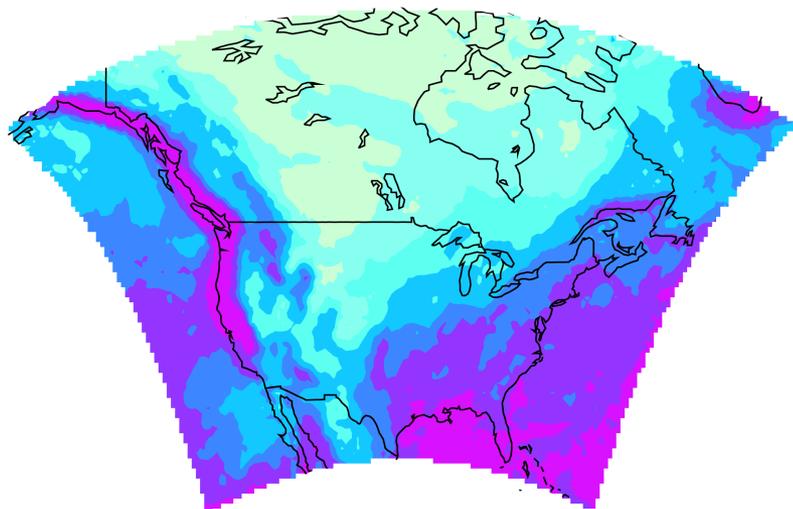
RCM3 (ncep)

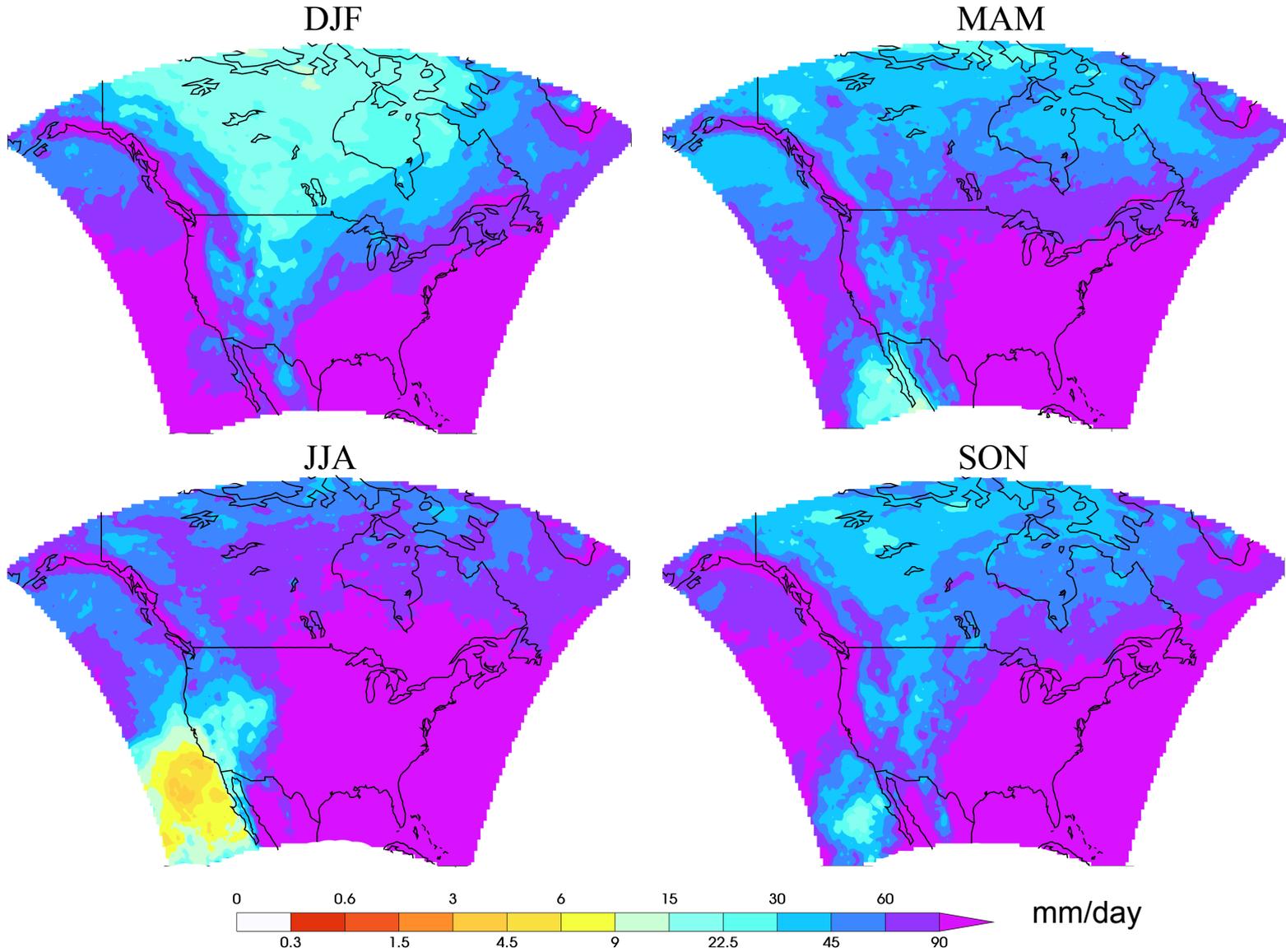
DJF

MAM

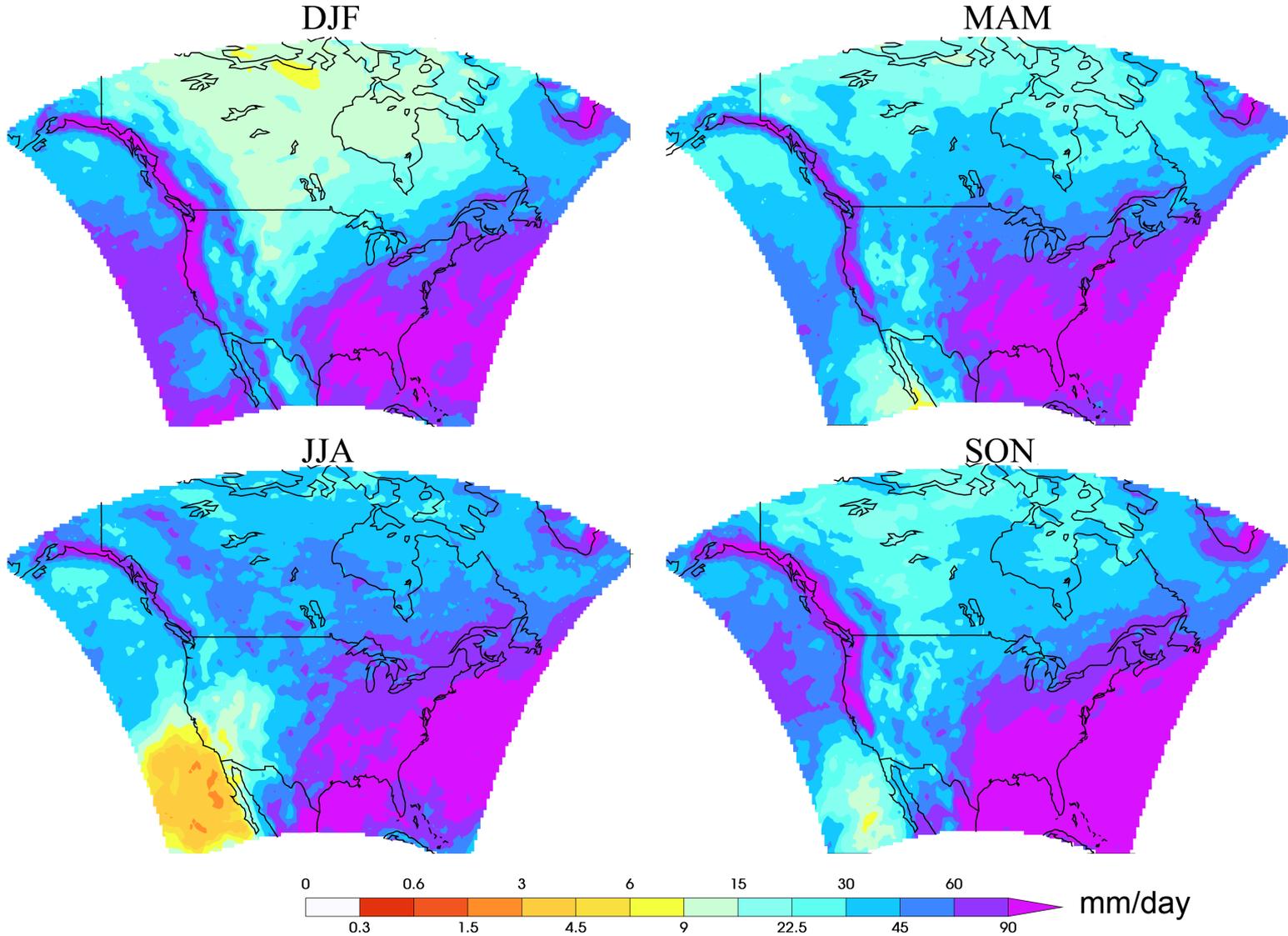
JJA

SON





WRFP (ncep)



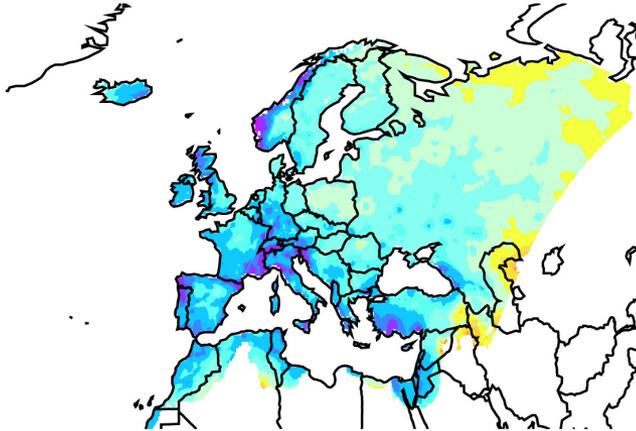
Implications for probabilistic extreme event attributions

- Uncertainty in the tail of the observed distribution of daily precipitation leads to uncertainty in the assessment of the actual rarity of a given event.
 - Some guidance from experts in observations (NOAA?) is in order.
- Model deficiencies are severe.
 - For CMIP5 class models:
 - Direct evaluation of the probability of a given magnitude of daily precipitation will be biased low, probably absurdly so.
 - Framing the attribution question in terms of rarity itself *may* be less ridiculous.
 1. Determine the probability of the event from observations.
 2. Determine what the model thinks the magnitude of that event is now.
 3. Determine the probability of the event in a non-industrial world.
 - Current generation high resolution models show promise.
 - Parameterization errors are most important, and are still large.
 - High resolution will not fix errors that are caused by other things...
 - Experience is limited (~4 modeling groups).
 - The Hi-Res MIP in CMIP6 presents an opportunity.

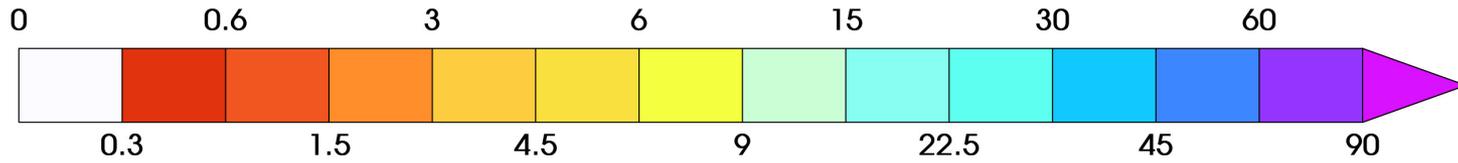
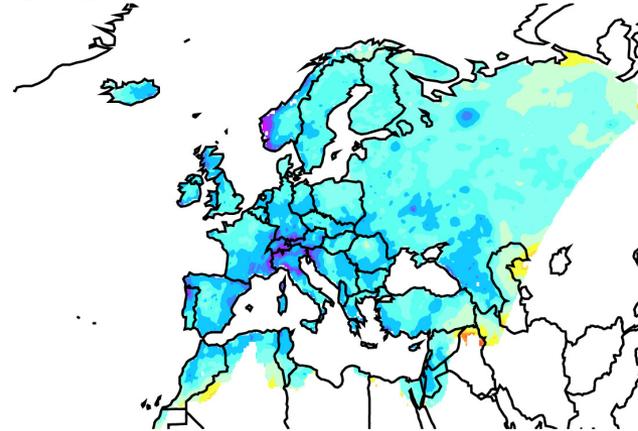


Thank you!
mfwehner@lbl.gov

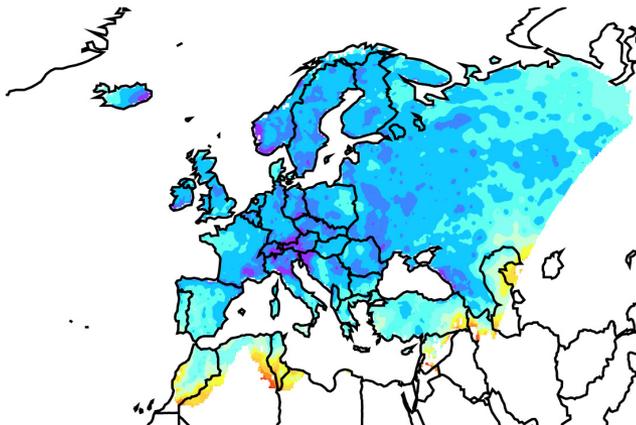
Winter



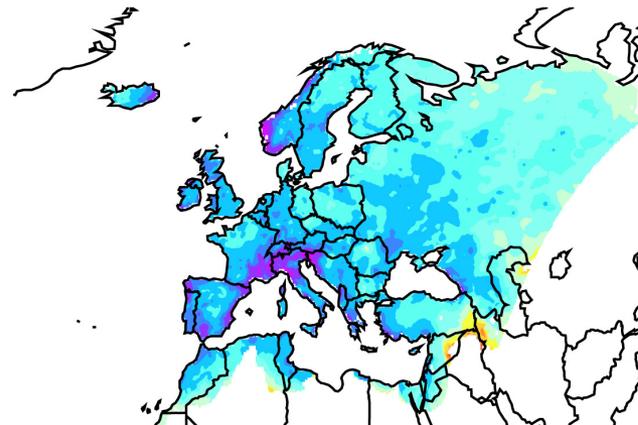
Spring



Summer

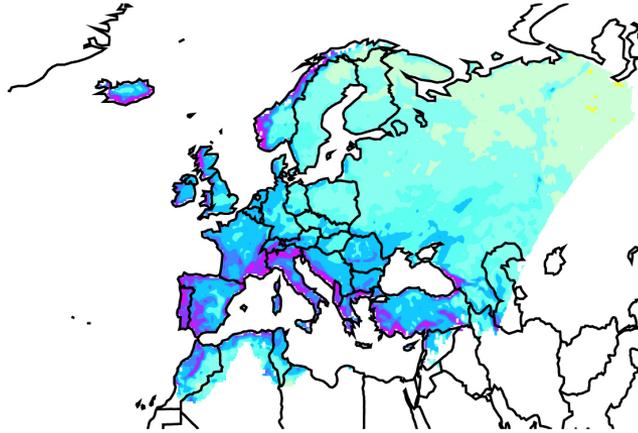


Fall

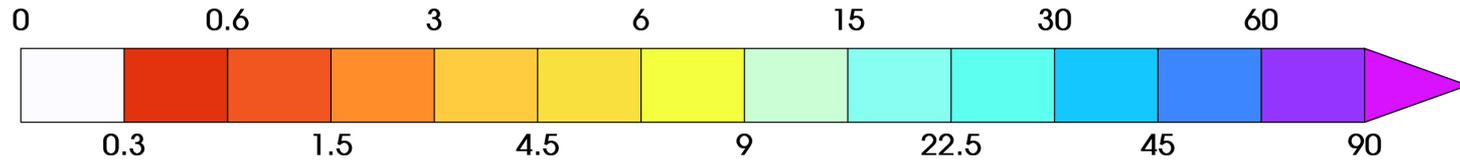
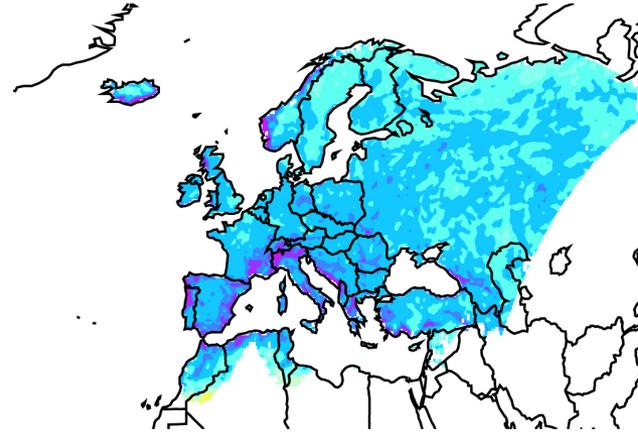


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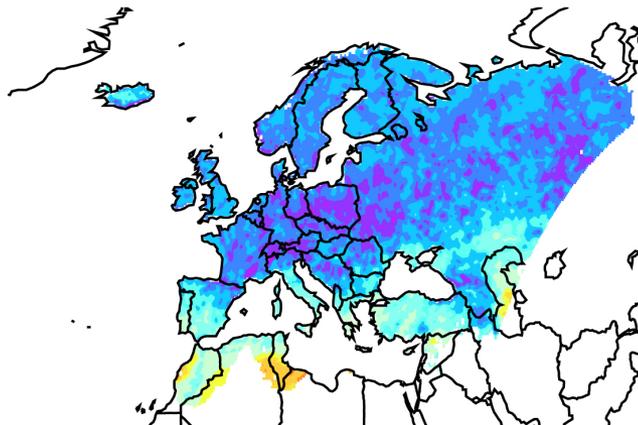
DJF



MAM



JJA



SON

